

**RTCA Special Committee 186, Working Group 3**

**ADS-B 1090 MOPS, Revision A**

**Meeting #15**

**Proposed Revisions for the Enhanced Squitter Reception Test  
Procedures for the Four-Pulse Preamble Detection Tests**

**Presented by John Van Dongen**

**SUMMARY**

**Section 2.4.4.4.2.2 Four-Pulse Preamble Detection Tests were written to test the enhanced preamble detection process when it was defined in Appendix I with an 8 MHz sampling rate. Appendix I now attempts to present the techniques independent of sampling rate but bases the description on a 10 MHz sampling rate for A3 equipment and an 8 MHz sampling rate for A2 equipment. The Four-Pulse Preamble Detection Test as currently defined pose problems for equipment that use either sampling rate. This working paper attempts to solve these problems.**

This working paper attempts to offer solutions for making the Four-Pulse Preamble Detection Tests valid for implementations independent of sampling rate.

**Note:** *Text Highlighted in YELLOW is not to be included in the MOPS.*

#### 2.4.4.4.2.2 Four-Pulse Preamble Detection Tests

##### Purpose/Introduction:

These tests verify that the ADS-B reply processor correctly detects the presence of a valid ADS-B preamble whose pulse characteristics are within the allowable limits and rejects preambles having pulse spacing and position characteristics that are outside the allowable limits.

##### Reference Input:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

“DF”	=	17
“CA”	=	0
“AA”	=	Any discrete address
Message Rate	=	50 Hz
Frequency	=	1090 MHz
Power	=	-23 dBm (for the first preamble pulse level)

##### Input A:

Same as the **Reference Input**, but having the following preamble pulse characteristics:

**Table 2.4.4.4.2.2.A: Input A: Preamble Pulse Characteristics**

<b>Input A: Preamble Pulse Characteristics</b>					
<b>Pulse</b>	<b>Rise time (μsec)</b>	<b>Fall time (μsec)</b>	<b>D Width (μsec)</b>	<b>D Position (μsec)</b>	<b>D Amplitude (dB)</b>
1	0.05 - 0.1	0.05 - 0.2	+0.05	—	—
2	0.05 - 0.1	0.05 - 0.2	-0.05	+0.1 <del>25</del>	+2
3	0.05 - 0.1	0.05 - 0.2	+0.05	+0.1 <del>25</del>	+2
4	0.05 - 0.1	0.05 - 0.2	-0.05	+0.1 <del>25</del>	0

### **Input B:**

Same as the **Reference Input**, but having the following preamble pulse characteristics:

**Table 2.4.4.4.2.2.B: Input B: Preamble Pulse Characteristics**

<b>Input B: Preamble Pulse Characteristics</b>					
<b>Pulse</b>	<b>Rise time (μsec)</b>	<b>Fall time (μsec)</b>	<b>D Width (μsec)</b>	<b>D Position (μsec)</b>	<b>D Amplitude (dB)</b>
1	0.05 - 0.1	0.05 - 0.2	+0.05	—	—
2	0.05 - 0.1	0.05 - 0.2	-0.05	-0.1 <del>25</del>	+2
3	0.05 - 0.1	0.05 - 0.2	+0.05	-0.1 <del>25</del>	+2
4	0.05 - 0.1	0.05 - 0.2	-0.05	-0.1 <del>25</del>	0

*Without this change, a 10 MHz implementation would fail steps 1 through 4 because the delta position put the pulses out of tolerance range. With this change an 8 or 10 MHz system will pass. This effectively sets the position tolerance to + or – .1 microseconds and no less, independent of sampling rate.*

### **Input C:**

Same as the **Reference Input**, but having the following preamble pulse characteristics:

**Table 2.4.4.4.2.2.C: Input C: Preamble Pulse Characteristics**

<b>Input C: Preamble Pulse Characteristics</b>					
<b>Pulse</b>	<b>Rise time (μsec)</b>	<b>Fall time (μsec)</b>	<b>D Width (μsec)</b>	<b>D Position (μsec)</b>	<b>D Amplitude (dB)</b>
1	0.05 - 0.1	0.05 - 0.2	-0.3	—	—
2	0.05 - 0.1	0.05 - 0.2	-0.3	0	0
3	0.05 - 0.1	0.05 - 0.2	-0.3	0	0
4	0.05 - 0.1	0.05 - 0.2	-0.3	0	0

**Input D:**

Same as the **Reference Input**, but having the following preamble pulse characteristics:

**Table 2.4.4.4.2.2.D: Input D: Preamble Pulse Characteristics**

<b>Input D: Preamble Pulse Characteristics</b>					
<b>Pulse</b>	<b>Rise time (<math>\mu</math>sec)</b>	<b>Fall time (<math>\mu</math>sec)</b>	<b>D Width (<math>\mu</math>sec)</b>	<b>D Position (<math>\mu</math>sec)</b>	<b>D Amplitude (dB)</b>
1	0.05 - 0.1	0.05 - 0.2	0	—	—
2	0.05 - 0.1	0.05 - 0.2	0	+0.2	0
3	0.05 - 0.1	0.05 - 0.2	0	+0.2	0
4	0.05 - 0.1	0.05 - 0.2	0	+0.2	0

**Input E:**

Same as the **Reference Input**, but having the following preamble pulse characteristics:

**Table 2.4.4.4.2.2.E: Input E: Preamble Pulse Characteristics**

<b>Input E: Preamble Pulse Characteristics</b>					
<b>Pulse</b>	<b>Rise time (<math>\mu</math>sec)</b>	<b>Fall time (<math>\mu</math>sec)</b>	<b>D Width (<math>\mu</math>sec)</b>	<b>D Position (<math>\mu</math>sec)</b>	<b>D Amplitude (dB)</b>
1	0.05 - 0.1	0.05 - 0.2	0	—	—
2	0.05 - 0.1	0.05 - 0.2	0	-0.125	0
3	0.05 - 0.1	0.05 - 0.2	0	0	0
4	0.05 - 0.1	0.05 - 0.2	0	+0.125	0

**Input F:**

Same as the **Reference Input**, but having the following preamble pulse characteristics:

**Table 2.4.4.4.2.2.F: Input F: Preamble Pulse Characteristics**

<b>Input F: Preamble Pulse Characteristics</b>					
<b>Pulse</b>	<b>Rise time (<math>\mu</math>sec)</b>	<b>Fall time (<math>\mu</math>sec)</b>	<b>D Width (<math>\mu</math>sec)</b>	<b>D Position (<math>\mu</math>sec)</b>	<b>D Amplitude (dB)</b>
1	0.05 - 0.1	0.05 - 0.2	0	—	—
2	0.05 - 0.1	0.05 - 0.2	0	0	0
3	0.05 - 0.1	0.05 - 0.2	0	+0.125	0
4	0.05 - 0.1	0.05 - 0.2	0	-0.125	0

### **Input G:**

Same as the **Reference Input**, but having the following preamble pulse characteristics:

**Table 2.4.4.2.2.G: Input G: Preamble Pulse Characteristics**

<b>Input G: Preamble Pulse Characteristics</b>					
<b>Pulse</b>	<b>Rise time (μsec)</b>	<b>Fall time (μsec)</b>	<b>D Width (μsec)</b>	<b>D Position (μsec)</b>	<b>D Amplitude (dB)</b>
1	0.05 - 0.1	0.05 - 0.2	+4.5	—	—
2	Pulse Not Present				
3	Pulse Not Present				
4	Pulse Not Present				

### **Measurement Procedure:**

The ADS-B receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level is adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures is lowered by 3 dB.

#### **Step 1: Preamble Pulse Characteristics set to the Extreme Limits of their Tolerance Range - Part 1**

Apply **Input A** at the receiver input and verify that at least 90 percent of the ADS-B Messages are correctly decoded.

#### **Step 2: Preamble Pulse Characteristics set to the Extreme Limits of their Tolerance Range - Part 2**

Repeat Step 1 with the signal power level at -65 dBm.

#### **Step 3: Preamble Pulse Characteristics set to the Extreme Limits of their Tolerance Range - Part 3**

Apply **Input B** at the receiver input and verify that at least 90 percent of the ADS-B Messages are correctly decoded.

#### **Step 4: Preamble Pulse Characteristics set to the Extreme Limits of their Tolerance Range - Part 4**

Repeat Step 3 with the signal power level at -65 dBm.

Step 5: Preamble Pulse Widths set to Out-of-Tolerance Values - Part 1

Apply **Input C** at the receiver input and verify that no more than 10 percent of the ADS-B Messages are correctly decoded.

Step 6: Preamble Pulse Widths set to Out-of-Tolerance Values - Part 2

Repeat Step 5 with the signal power level at -65 dBm.

Step 7: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 1

Apply **Input D** at the receiver input and verify that no more than 10 percent of the ADS-B Messages are correctly decoded for A3 equipment class, or no more than 40 percent of the ADS-B Messages are correctly decoded for A2 equipment class.

*Without this change, an 8 MHz sampling rate implementation could not pass the test because the defined pulse positions are partially within the tolerance range of the receiver.*

Step 8: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 2

Repeat Step 7 with the signal power level at -65 dBm.

Step 9: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 3

Apply **Input E** at the receiver input and verify that no more than 10 percent of the ADS-B Messages are correctly decoded.

Step 10: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 4

Repeat Step 9 with the signal power level at -65 dBm.

Step 11: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 5

Apply **Input F** at the receiver input and verify that no more than 10 percent of the ADS-B Messages are correctly decoded.

Step 12: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 6

Repeat Step 11 with the signal power level at -65 dBm.

Step 13: Preamble Single Pulse - Part 1

Apply **Input G** at the receiver input and verify that no more than 10 percent of the ADS-B Messages are correctly decoded.

Step 14: Preamble Single Pulse - Part 2

Repeat Step 13 with the signal power level at -65 dBm.

#### 2.4.4.4.2.3 Preamble Validation Tests

*The following change to the preamble validation tests reflect the change to appendix I that now requires not only a pulse in each of the first 5 data bit positions, but that the pulse is within 6 dB of the reference level established by the four-pulse preamble.*

##### Purpose/Introduction:

These tests verify that the ADS-B reply processor correctly validates the ADS-B preamble. It is verified that when energy with an amplitude within 6 dB of the preamble reference level is contained in at least one chip of the first five data bits the preamble is accepted and the preamble is rejected if one or more of the first five data bits has insufficient energy in either chip.

##### Reference Input:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:		
“DF”	=	17
“CA”	=	0
“AA”	=	Any discrete address
Message Rate	=	50 Hz
Frequency	=	1090 MHz
Power	=	-23 dBm

The transmitted power in the first six data bits is controlled in such a way that the amplitude of a data bit can be set independently of the others.~~occur with no power being transmitted in either chip.~~

##### Measurement Procedure:

The ADS-B receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level is adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures is lowered by 3 dB.

For this test to be valid the receiver must perform error correction.

##### Step 1: Preamble Validation – Missing First Data Bit - Part 1

Input the Reference Input DF=17 messages with the amplitude of the first data bit set to -30 dBm~~no energy in either chip of the first data bit~~ into the receiver and verify that less than 10 percent of the ADS-B Messages are correctly decoded.

Step 2: Preamble Validation – Missing First Data Bit - Part 2

Repeat Step 1 with the signal power level at -65 dBm and the first bit at -72 dBm.

Step 3: Preamble Validation – Missing Second Data Bit - Part 1

Input the Reference Input DF=17 messages with the amplitude of the second data bit set to -30 dBm~~no energy in either chip of the second data bit~~ into the receiver and verify that less than 10 percent of the ADS-B Messages are correctly decoded.

Step 4: Preamble Validation – Missing Second Data Bit - Part 2

Repeat Step 3 with the signal power level at -65 dBm and the second bit at -72 dBm.

Step 5: Preamble Validation – Missing Third Data Bit - Part 1

Input the Reference Input DF=17 messages with the amplitude of the third data bit set to -30 dBm~~no energy in either chip of the third data bit~~ into the receiver and verify that less than 10 percent of the ADS-B Messages are correctly decoded.

Step 6: Preamble Validation – Missing Third Data Bit - Part 2

Repeat Step 5 with the signal power level at -65 dBm and the third bit at -72 dBm.

Step 7: Preamble Validation – Missing Fourth Data Bit - Part 1

Input the Reference Input DF=17 messages with the amplitude of the fourth data bit set to -30 dBm~~no energy in either chip of the first data bit~~ into the receiver and verify that less than 10 percent of the ADS-B Messages are correctly decoded.

Step 8: Preamble Validation – Missing Fourth Data Bit - Part 2

Repeat Step 7 with the signal power level at -65 dBm and the fourth bit at -72 dBm.

Step 9: Preamble Validation – Missing Fifth Data Bit - Part 1

Input the Reference Input DF=17 messages with the amplitude of the fifth data bit set to -30 dBm~~no energy in either chip of the fifth data bit~~ into the receiver and verify that less than 10 percent of the ADS-B Messages are correctly decoded.

Step 10: Preamble Validation – Missing Fifth Data Bit - Part 2

Repeat Step 9 with the signal power level at -65 dBm and the fifth bit at -72 dBm.



Step 11: Preamble Validation – Missing Sixth Data Bit - Part 1

Input the [Reference Input](#) DF=17 messages with no energy in either chip of the sixth data bit into the receiver and verify that greater than 90 percent of the ADS-B Messages are correctly decoded.

Step 12: Preamble Validation – Missing Sixth Data Bit - Part 2

Repeat Step 11 with the signal power level at -65 dBm.